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The valorization of municipal grass waste for the extraction of cellulose nanocrystals

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Abstract

The study reports on the valorization of municipal grass waste (MGW) for the extraction of cellulose nanocrystals (CNCs), as an eco-friendly and sustainable low-cost precursor for cellulose nanomaterial production. The raw MGW was subjected to boiling in water pretreatment, and alkali and bleaching treatments for the extraction of cellulose fibers, followed by isolation of the CNCs through a conventional acid hydrolysis technique. Fourier transform infrared spectroscopy was used to analyze the cellulose fibers extracted while scanning electron microscopy and transmission electron microscopy images confirmed the presence of cellulose fibers and CNCs, respectively. The chemical composition of MGW was ascertained through the TAPPI-222 om-02 standard for lignin content and determination of α- cellulose . The diameters of CNCs are in the range of 5-15 nm with the length ranging from 100 nm to 500 nm, while a crystallinity index of 58.2% was determined from X-ray diffraction analysis. The production of CNCs from MGW is an avenue to convert green waste into a value-added product, in addition to reducing the volume of cumulative waste in the environment. This journal is © The Royal Society of Chemistry.

PaperChem Variable
Acidolysis; Boiling; Cellulose Fibers; Extraction ; Production; Scanning Electron Microscopy; TAPPI; Wastes

Engineering controlled terms
Cellulose ; Cellulose nanocrystals ; Crystallinity; Extraction ; Fourier transform infrared spectroscopy; High resolution transmission electron microscopy; Natural fibers; Scanning electron microscopy; Textile fibers; X ray powder diffraction

Engineering uncontrolled terms

Bleaching treatment; Cellulose nanocrystal (CNCs); Chemical compositions; Crystallinity index; Low-cost precursor; Transmission electron microscopy images; Value added products; Water pretreatment

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References (66)

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All

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1 Habibi, Y., Lucia, L.A., Rojas, O.J.

Cellulose nanocrystals: Chemistry, self-assembly, and applications

(2010) *Chemical Reviews*, 110 (6), pp. 3479-3500. Cited 3521 times.
doi: 10.1021/cr900339w

View at Publisher

2 Kontturi, E., Laaksonen, P., Linder, M.B., Nonappa, Gröschel, A.H., Rojas, O.J., Ikkala, O.

Advanced Materials through Assembly of Nanocelluloses (Open Access)

(2018) *Advanced Materials*, 30 (24), art. no. 1703779. Cited 260 times.
http://onlinelibrary.wiley.com.ezlib.iium.edu.my/journal/10.1002/(ISSN)1521-4095
doi: 10.1002/adma.201703779

View at Publisher

3 Cao, L., Liu, C., Zou, D., Zhang, S., Chen, Y.

Using cellulose nanocrystals as sustainable additive to enhance mechanical and shape memory properties of PLA/ENR thermoplastic vulcanizates

(2020) *Carbohydrate Polymers*, 230, art. no. 115618. Cited 36 times.
http://www.elsevier.com.ezlib.iium.edu.my/wps/find/journaldescription.cws_home/405871/description#description
doi: 10.1016/j.carbpol.2019.115618

View at Publisher

4 Hynninen, V., Mohammadi, P., Wagermaier, W., Hietala, S., Linder, M.B., Ikkala, O., Nonappa

Methyl cellulose/cellulose nanocrystal nanocomposite fibers with high ductility (Open Access)

(2019) *European Polymer Journal*, 112, pp. 334-345. Cited 11 times.
doi: 10.1016/j.eurpolymj.2018.12.035

View at Publisher

5 Lavoine, N., Bergström, L.

Nanocellulose-based foams and aerogels: Processing, properties, and applications (Open Access)

(2017) *Journal of Materials Chemistry A*, 5 (31), pp. 16105-16117. Cited 242 times.
http://pubs.rsc.org/en/journals/journalissues/ta
doi: 10.1039/c7ta02807e

View at Publisher

6 Prakash Menon, M., Selvakumar, R., Suresh Kumar, P., Ramakrishna, S.

Extraction and modification of cellulose nanofibers derived from biomass for environmental application (Open Access)

(2017) *RSC Advances*, 7 (68), pp. 42750-42773. Cited 62 times.
http://pubs.rsc.org/en/journals/journalissues
doi: 10.1039/c7ra06713e

View at Publisher

7 Mariano, M., El Kissi, N., Dufresne, A.

Cellulose nanocrystals and related nanocomposites: Review of some properties and challenges

(2014) *Journal of Polymer Science, Part B: Polymer Physics*, 52 (12), pp. 791-806. Cited 473 times.
http://www.interscience.wiley.com.ezlib.iium.edu.my/jpages/0887-6266
doi: 10.1002/polb.23490

View at Publisher

8 Motaung, T.E., Linganiso, L.Z.

Critical review on agrowaste cellulose applications for biopolymers

(2018) *International Journal of Plastics Technology*, 22 (2), pp. 185-216. Cited 20 times.
http://www.springer.com.ezlib.iium.edu.my/chemistry/polymer+science/journal/12588
doi: 10.1007/s12588-018-9219-6

View at Publisher

9 Kang, X., Kuga, S., Wang, C., Zhao, Y., Wu, M., Huang, Y.

Green Preparation of Cellulose Nanocrystal and Its Application

(2018) *ACS Sustainable Chemistry and Engineering*, 6 (3), pp. 2954-2960. Cited 52 times.
http://pubs.acs.org.ezlib.iium.edu.my/journal/ascecg
doi: 10.1021/acssuschemeng.7b02363

View at Publisher

10 Kumar, S., Falzon, B.G., Kun, J., Wilson, E., Graninger, G., Hawkins, S.C.

High performance multiscale glass fibre epoxy composites integrated with cellulose nanocrystals for advanced structural applications (Open Access)

(2020) *Composites Part A: Applied Science and Manufacturing*, 131, art. no. 105801. Cited 9 times.
https://www.journals.elsevier.com/composites-part-a-applied-science-and-manufacturing
doi: 10.1016/j.compositesa.2020.105801

View at Publisher

11 Liu, X., Yang, K., Chang, M., Wang, X., Ren, J.

Fabrication of cellulose nanocrystal reinforced nanocomposite hydrogel with self-healing properties

(2020) *Carbohydrate Polymers*, 240, art. no. 116289. Cited 13 times.
http://www.elsevier.com.ezlib.iium.edu.my/wps/find/journaldescription.cws_home/405871/description#description
doi: 10.1016/j.carbpol.2020.116289

View at Publisher

12 Shaghaleh, H., Xu, X., Wang, S.

Current progress in production of biopolymeric materials based on cellulose, cellulose nanofibers, and cellulose derivatives (Open Access)

(2018) *RSC Advances*, 8 (2), pp. 825-842. Cited 91 times.
http://pubs.rsc.org/en/journals/journal/ra
doi: 10.1039/c7ra11157f

View at Publisher

13 Du, H., Liu, W., Zhang, M., Si, C., Zhang, X., Li, B.

Cellulose nanocrystals and cellulose nanofibrils based hydrogels for biomedical applications

(2019) *Carbohydrate Polymers*, 209, pp. 130-144. Cited 246 times.
http://www.elsevier.com.ezlib.iium.edu.my/wps/find/journaldescription.cws_home/405871/description#description
doi: 10.1016/j.carbpol.2019.01.020

View at Publisher

14 Yadav, M., Chiu, F.-C.

Cellulose nanocrystals reinforced κ-carrageenan based UV resistant transparent bionanocomposite films for sustainable packaging applications

(2019) *Carbohydrate Polymers*, 211, pp. 181-194. Cited 63 times.
http://www.elsevier.com.ezlib.iium.edu.my/wps/find/journaldescription.cws_home/405871/description#description
doi: 10.1016/j.carbpol.2019.01.114

View at Publisher

15 Mujica-Garcia, A., Hooshmand, S., Skrifvars, M., Kenny, J.M., Oksman, K., Peponi, L.

Poly(lactic acid) melt-spun fibers reinforced with functionalized cellulose nanocrystals

(2016) *RSC Advances*, 6 (11), pp. 9221-9231. Cited 50 times.
http://pubs.rsc.org/en/journals/journalissues
doi: 10.1039/c5ra22818b

View at Publisher

16 Karim, Z., Mathew, A.P., Kokol, V., Wei, J., Grahn, M.

High-flux affinity membranes based on cellulose nanocomposites for removal of heavy metal ions from industrial effluents (Open Access)

(2016) *RSC Advances*, 6 (25), pp. 20644-20653. Cited 48 times.
http://pubs.rsc.org/en/journals/journalissues
doi: 10.1039/c5ra27059f

View at Publisher

17 Bumbudsanpharoke, N., Kwon, S., Lee, W., Ko, S.

Optical response of photonic cellulose nanocrystal film for a novel humidity indicator

(2019) *International Journal of Biological Macromolecules*, 140, pp. 91-97. Cited 11 times.
www.elsevier.com/locate/ijbiomac
doi: 10.1016/j.ijbiomac.2019.08.055

View at Publisher

18 Oyewo, O.A., Mutesse, B., Leswifi, T.Y., Onyango, M.S.

Highly efficient removal of nickel and cadmium from water using sawdust-derived cellulose nanocrystals

(2019) *Journal of Environmental Chemical Engineering*, 7 (4), art. no. 103251. Cited 21 times.
http://www.journals.elsevier.com/journal-of-environmental-chemical-engineering/
doi: 10.1016/j.jece.2019.103251

View at Publisher

19 Yu, F., Zhou, Y., Qiao, H., Sun, L., Li, L., Feng, C., Li, Y.

Adsorption of ionic liquid from aqueous solutions using functional corncob-cellulose nanocrystals

(2016) *RSC Advances*, 6 (108), pp. 106547-106554. Cited 8 times.
http://pubs.rsc.org/en/journals/journalissues
doi: 10.1039/c6ra22918b

View at Publisher

20 Gong, J., Li, J., Xu, J., Xiang, Z., Mo, L.

Research on cellulose nanocrystals produced from cellulose sources with various polymorphs (Open Access)

(2017) *RSC Advances*, 7 (53), pp. 33486-33493. Cited 101 times.
http://pubs.rsc.org/en/journals/journal/ra
doi: 10.1039/c7ra06222b

View at Publisher

21 Trache, D., Hussin, M.H., Haafiz, M.K.M., Thakur, V.K.

Recent progress in cellulose nanocrystals: Sources and production (Open Access)

(2017) *Nanoscale*, 9 (5), pp. 1763-1786. Cited 419 times.
http://pubs.rsc.org/en/journals/journal/nr
doi: 10.1039/c6nr09494e

View at Publisher

22 Campano, C., Miranda, R., Merayo, N., Negro, C., Blanco, A.

Direct production of cellulose nanocrystals from old newspapers and recycled newsprint

(2017) *Carbohydrate Polymers*, 173, pp. 489-496. Cited 27 times.
http://www.elsevier.com.ezlib.iium.edu.my/wps/find/journaldescription.cws_home/405871/description#description
doi: 10.1016/j.carbpol.2017.05.073

View at Publisher

23 Danial, W.H., Abdul Majid, Z., Mohd Muhid, M.N., Triwahyono, S., Bakar, M.B., Ramli, Z.

The reuse of wastepaper for the extraction of cellulose nanocrystals

(2015) *Carbohydrate Polymers*, 118, pp. 165-169. Cited 81 times.
http://www.elsevier.com.ezlib.iium.edu.my/wps/find/journaldescription.cws_home/405871/description#description
doi: 10.1016/j.carbpol.2014.10.072

View at Publisher

24 Hanafiah, S.F.M., Danial, W.H., Samah, M.A.A., Samad, W.Z., Susanti, D., Salim, R.M., Majid, Z.A.

Extraction and characterization of microfibrillated and nanofibrillated cellulose from office paper waste

(2019) *Malaysian Journal of Analytical Sciences*, 23 (5), pp. 901-913. Cited 2 times.
http://www.ukm.my/mjas/v23_n5/pdf/Fatimah_23_5_15.pdf
doi: 10.17576/mjas-2019-2305-15

View at Publisher

25 Orue, A., Santamaria-Echart, A., Eceiza, A., Peña-Rodriguez, C., Arbelaiz, A.

Office waste paper as cellulose nanocrystal source

(2017) *Journal of Applied Polymer Science*, 134 (35), art. no. 45257. Cited 32 times.
http://onlinelibrary.wiley.com.ezlib.iium.edu.my/journal/10.1002/(ISSN)1097-4628
doi: 10.1002/app.45257

View at Publisher

26 Peretz, R., Sterenzon, E., Gerchman, Y., Kumar Vadivel, V., Luxbacher, T., Mamane, H.

Nanocellulose production from recycled paper mill sludge using ozonation pretreatment followed by recyclable maleic acid hydrolysis

(2019) *Carbohydrate Polymers*, 216, pp. 343-351. Cited 18 times.
http://www.elsevier.com.ezlib.iium.edu.my/wps/find/journaldescription.cws_home/405871/description#description
doi: 10.1016/j.carbpol.2019.04.003

View at Publisher

27 Dong, H., Strawhecker, K.E., Snyder, J.F., Orlicki, J.A., Reiner, R.S., Rudie, A.W.

Cellulose nanocrystals as a reinforcing material for electrospun poly(methyl methacrylate) fibers: Formation, properties and nanomechanical characterization

(2012) *Carbohydrate Polymers*, 87 (4), pp. 2488-2495. Cited 171 times.
http://www.elsevier.com.ezlib.iium.edu.my/wps/find/journaldescription.cws_home/405871/description#description
doi: 10.1016/j.carbpol.2011.11.015

View at Publisher

28 Dong, S., Bortner, M.J., Roman, M.

Analysis of the sulfuric acid hydrolysis of wood pulp for cellulose nanocrystal production: A central composite design study (Open Access)

(2016) *Industrial Crops and Products*, 93, pp. 76-87. Cited 64 times.
www.elsevier.com/inca/publications/store/5/2/2/8/2/5
doi: 10.1016/j.indcrop.2016.01.048

View at Publisher

29 Phanthong, P., Karnjanakom, S., Reubroycharoen, P., Hao, X., Abudula, A., Guan, G.

A facile one-step way for extraction of nanocellulose with high yield by ball milling with ionic liquid

(2017) *Cellulose*, 24 (5), pp. 2083-2093. Cited 49 times.
doi: 10.1007/s10570-017-1238-5

View at Publisher

30 Di Giorgio, L., Martín, L., Salgado, P.R., Mauri, A.N.

Synthesis and conservation of cellulose nanocrystals

(2020) *Carbohydrate Polymers*, 238, art. no. 116187. Cited 9 times.
http://www.elsevier.com.ezlib.iium.edu.my/wps/find/journaldescription.cws_home/405871/description#description
doi: 10.1016/j.carbpol.2020.116187

View at Publisher

31 Hemmati, F., Jafari, S.M., Taheri, R.A.

Optimization of homogenization-sonication technique for the production of cellulose nanocrystals from cotton linter

(2019) *International Journal of Biological Macromolecules*, 137, pp. 374-381. Cited 16 times.
www.elsevier.com/locate/ijbiomac
doi: 10.1016/j.ijbiomac.2019.06.241

View at Publisher

32 Luzi, F., Fortunati, E., Puglia, D., Lavorgna, M., Santulli, C., Kenny, J.M., Torre, L.

Optimized extraction of cellulose nanocrystals from pristine and carded hemp fibres

(2014) *Industrial Crops and Products*, 56, pp. 175-186. Cited 66 times.
www.elsevier.com/inca/publications/store/5/2/2/8/2/5
doi: 10.1016/j.indcrop.2014.03.006

View at Publisher

33 Mariano, M., Cercená, R., Soldi, V.

Thermal characterization of cellulose nanocrystals isolated from sisal fibers using acid hydrolysis

(2016) *Industrial Crops and Products*, 94, pp. 454-462. Cited 71 times.
www.elsevier.com/inca/publications/store/5/2/2/8/2/5
doi: 10.1016/j.indcrop.2016.09.011

View at Publisher

34 Bhange, V.P., William, S.P.M.P., Vaidya, A.N., Chokhandre, A.R.
(2012) *Int. J. Recent Trends Sci. Technol.*, 4, pp. 22-33. Cited 4 times.

35 Bustamante, M.A., Ceglie, F.G., Aly, A., Mihreteab, H.T., Ciaccia, C., Tittarelli, F.

Phosphorus availability from rock phosphate: Combined effect of green waste composting and sulfur addition

(2016) *Journal of Environmental Management*, 182, pp. 557-563. Cited 39 times.
http://www.elsevier.com.ezlib.iium.edu.my/inca/publications/store/6/2/2/8/7/1/index.htt
doi: 10.1016/j.jenvman.2016.08.016

View at Publisher

36 López, M., Soliva, M., Martínez-Farré, F.X., Bonmatí, A., Huerta-Pujol, O.

An assessment of the characteristics of yard trimmings and recirculated yard trimmings used in biowaste composting

(2010) *Bioresource Technology*, 101 (4), pp. 1399-1405. Cited 33 times.
doi: 10.1016/j.biortech.2009.09.031

View at Publisher

37 Hernández-Gómez, A., Calderón, A., Medina, C., Sanchez-Torres, V., Oviedo-Ocaña, E.R.
(2020) *Environ. Sci. Pollut. Res.*, pp. 1-7. Cited 11 times.

38 Leão, R.M., Miléo, P.C., Maia, J.M.L.L., Luz, S.M.

Environmental and technical feasibility of cellulose nanocrystal manufacturing from sugarcane bagasse

(2017) *Carbohydrate Polymers*, 175, pp. 518-529. Cited 28 times.
http://www.elsevier.com.ezlib.iium.edu.my/wps/find/journaldescription.cws_home/405871/description#description
doi: 10.1016/j.carbpol.2017.07.087

View at Publisher

39 Lu, P., Hsieh, Y.-L.

Preparation and characterization of cellulose nanocrystals from rice straw

(2012) *Carbohydrate Polymers*, 87 (1), pp. 564-573. Cited 347 times.
doi: 10.1016/j.carbpol.2011.08.022

View at Publisher

40 Wibowo, A., Madani, H., Judawisastra, H., Restiawaty, E., Lazarus, C., Budhi, Y.W.

An eco-friendly preparation of cellulose nano crystals from oil palm empty fruit bunches (Open Access)

(2018) *IOP Conference Series: Earth and Environmental Science*, 105 (1), art. no. 012059. Cited 4 times.
http://www.iop.org/EJ/volume/1755-1315
doi: 10.1088/1755-1315/105/1/012059

View at Publisher

41 Melikoğlu, A.Y., Bilek, S.E., Cesur, S.

Optimum alkaline treatment parameters for the extraction of cellulose and production of cellulose nanocrystals from apple pomace

(2019) *Carbohydrate Polymers*, 215, pp. 330-337. Cited 46 times.
http://www.elsevier.com.ezlib.iium.edu.my/wps/find/journaldescription.cws_home/405871/description#description
doi: 10.1016/j.carbpol.2019.03.103

View at Publisher

42 Sai Prasanna, N., Mitra, J.

Isolation and characterization of cellulose nanocrystals from Cucumis sativus peels

(2020) *Carbohydrate Polymers*, 247, art. no. 116706. Cited 10 times.
http://www.elsevier.com.ezlib.iium.edu.my/wps/find/journaldescription.cws_home/405871/description#description
doi: 10.1016/j.carbpol.2020.116706

View at Publisher

43 Jiang, F., Hsieh, Y.-L.

Cellulose nanocrystal isolation from tomato peels and assembled nanofibers (Open Access)

(2015) *Carbohydrate Polymers*, 122, pp. 60-68. Cited 156 times.
http://www.elsevier.com.ezlib.iium.edu.my/wps/find/journaldescription.cws_home/405871/description#description
doi: 10.1016/j.carbpol.2014.12.064

View at Publisher

44 Madureira, A.R., Atatoprak, T., Çabuk, D., Sousa, F., Pullar, R.C., Pintado, M.

Extraction and characterisation of cellulose nanocrystals from pineapple peel (Open Access)

(2018) *International Journal of Food Studies*, 7 (1), pp. 24-33. Cited 8 times.
https://www.iseki-food-ejournal.com/ojs/index.php/e-journal/article/download/389/203
doi: 10.7455/ijfs/7.1.2018.a3

View at Publisher

45 Hafemann, E., Battisti, R., Marangoni, C., Machado, R.A.F.

Valorization of royal palm tree agroindustrial waste by isolating cellulose nanocrystals

(2019) *Carbohydrate Polymers*, 218, pp. 188-198. Cited 19 times.
http://www.elsevier.com.ezlib.iium.edu.my/wps/find/journaldescription.cws_home/405871/description#description
doi: 10.1016/j.carbpol.2019.04.086

View at Publisher

☐ 46 de Assis, C.A., Houtman, C., Phillips, R., Bilek, E.M.T., Rojas, O.J., Pal, L., Peresin, M.S., (...), Gonzalez, R.

Conversion Economics of Forest Biomaterials: Risk and Financial Analysis of CNC Manufacturing

(2017) *Biofuels, Bioproducts and Biorefining*, 11 (4), pp. 682-700. Cited 56 times.
http://www3.interscience.wiley.com.ezlib.iium.edu.my
doi: 10.1002/bbb.1782

View at Publisher

☐ 47 Candido, R.G., Gonçalves, A.R.

Synthesis of cellulose acetate and carboxymethylcellulose from sugarcane straw

(2016) *Carbohydrate Polymers*, 152, pp. 679-686. Cited 80 times.
http://www.elsevier.com.ezlib.iium.edu.my/wps/find/journaldescription.cws_home/405871/description#description
doi: 10.1016/j.carbpol.2016.07.071

View at Publisher

☐ 48 Segal, L., Creely, J.J., Martin, A.E., Conrad, C.M.

An Empirical Method for Estimating the Degree of Crystallinity of Native Cellulose Using the X-Ray Diffractometer

(1959) *Textile Research Journal*, 29 (10), pp. 786-794. Cited 4797 times.
doi: 10.1177/004051755902901003

View at Publisher

☐ 49 Tserki, V., Zafeiropoulos, N.E., Simon, F., Panayiotou, C.

A study of the effect of acetylation and propionylation surface treatments on natural fibres

(2005) *Composites Part A: Applied Science and Manufacturing*, 36 (8), pp. 1110-1118. Cited 416 times.
doi: 10.1016/j.compositesa.2005.01.004

View at Publisher

☐ 50 Roncero, M.B., Torres, A.L., Colom, J.F., Vidal, T.

The effect of xylanase on lignocellulosic components during the bleaching of wood pulps

(2005) *Bioresource Technology*, 96 (1), pp. 21-30. Cited 148 times.
doi: 10.1016/j.biortech.2004.03.003

View at Publisher

☐ 51 Johar, N., Ahmad, I., Dufresne, A.

Extraction, preparation and characterization of cellulose fibres and nanocrystals from rice husk

(2012) *Industrial Crops and Products*, 37 (1), pp. 93-99. Cited 732 times.
doi: 10.1016/j.indcrop.2011.12.016

View at Publisher

52 Yan, X., Cheng, J.-R., Wang, Y.-T., Zhu, M.-J.

Enhanced lignin removal and enzymolysis efficiency of grass waste by hydrogen peroxide synergized dilute alkali pretreatment

(2020) *Bioresource Technology*, 301, art. no. 122756. Cited 20 times.
www.elsevier.com/locate/biortech
doi: 10.1016/j.biortech.2020.122756

View at Publisher

53 Garside, P., Wyeth, P.

Identification of Cellulosic Fibres by FTIR Spectroscopy: Thread and Single Fibre Analysis by Attenuated Total Reflectance (Open Access)

(2004) *Studies in Conservation*, 48 (4), pp. 269-275. Cited 287 times.
http://www-tandfonline-com.ezlib.iium.edu.my/loi/ysic20#.VwHceE1f1Qs
doi: 10.1179/sic.2003.48.4.269

View at Publisher

54 Li, Y., Liu, Y., Chen, W., Wang, Q., Liu, Y., Li, J., Yu, H.

Facile extraction of cellulose nanocrystals from wood using ethanol and peroxide solvothermal pretreatment followed by ultrasonic nanofibrillation

(2016) *Green Chemistry*, 18 (4), pp. 1010-1018. Cited 105 times.
http://pubs.rsc.org/en/journals/journal/gc
doi: 10.1039/c5gc02576a

View at Publisher

55 Cherian, B.M., Leão, A.L., de Souza, S.F., Thomas, S., Pothan, L.A., Kottaisamy, M.

Isolation of nanocellulose from pineapple leaf fibres by steam explosion

(2010) *Carbohydrate Polymers*, 81 (3), pp. 720-725. Cited 398 times.
doi: 10.1016/j.carbpol.2010.03.046

View at Publisher

56 Lu, H., Gui, Y., Zheng, L., Liu, X.

Morphological, crystalline, thermal and physicochemical properties of cellulose nanocrystals obtained from sweet potato residue

(2013) *Food Research International*, 50 (1), pp. 121-128. Cited 119 times.
doi: 10.1016/j.foodres.2012.10.013

View at Publisher

57 Lee, M., Heo, M.H., Lee, H., Lee, H.-H., Jeong, H., Kim, Y.-W., Shin, J.

Facile and eco-friendly extraction of cellulose nanocrystals: Via electron beam irradiation followed by high-pressure homogenization

(2018) *Green Chemistry*, 20 (11), pp. 2596-2610. Cited 26 times.
http://pubs.rsc.org/en/journals/journal/gc
doi: 10.1039/c8gc00577j

View at Publisher

58 Zhou, Y., Saito, T., Bergström, L., Isogai, A.
Acid-Free Preparation of Cellulose Nanocrystals by TEMPO Oxidation and Subsequent Cavitation

(2018) *Biomacromolecules*, 19 (2), pp. 633-639. Cited 87 times.
http://pubs.acs.org.ezlib.iium.edu.my/journal/bomaf6
doi: 10.1021/acs.biomac.7b01730

View at Publisher

59 Mohd Amin, K.N., Annamalai, P.K., Morrow, I.C., Martin, D.
Production of cellulose nanocrystals via a scalable mechanical method (Open Access)

(2015) *RSC Advances*, 5 (70), pp. 57133-57140. Cited 38 times.
http://pubs.rsc.org/en/journals/journalissues
doi: 10.1039/c5ra06862b

View at Publisher

60 Cao, X., Ding, B., Yu, J., Al-Deyab, S.S.
Cellulose nanowhiskers extracted from TEMPO-oxidized jute fibers

(2012) *Carbohydrate Polymers*, 90 (2), pp. 1075-1080. Cited 128 times.
doi: 10.1016/j.carbpol.2012.06.046

View at Publisher

61 French, A.D., Santiago Cintrón, M.
Cellulose polymorphy, crystallite size, and the Segal Crystallinity Index

(2013) *Cellulose*, 20 (1), pp. 583-588. Cited 460 times.
www.springer.com/journal/10570
doi: 10.1007/s10570-012-9833-y

View at Publisher

62 Asempour, F., Emadzadeh, D., Matsuura, T., Kruczek, B.
Synthesis and characterization of novel Cellulose Nanocrystals-based Thin Film Nanocomposite membranes for reverse osmosis applications

(2018) *Desalination*, 439, pp. 179-187. Cited 59 times.
doi: 10.1016/j.desal.2018.04.009

View at Publisher

63 Li, J., Wei, X., Wang, Q., Chen, J., Chang, G., Kong, L., Su, J., (...), Liu, Y.
Homogeneous isolation of nanocellulose from sugarcane bagasse by high pressure homogenization

(2012) *Carbohydrate Polymers*, 90 (4), pp. 1609-1613. Cited 292 times.
doi: 10.1016/j.carbpol.2012.07.038

View at Publisher

64 Han, J., Zhou, C., French, A.D., Han, G., Wu, Q.
Characterization of cellulose II nanoparticles regenerated from 1-butyl-3-methylimidazolium chloride

(2013) *Carbohydrate Polymers*, 94 (2), pp. 773-781. Cited 125 times.
doi: 10.1016/j.carbpol.2013.02.003

View at Publisher

65 Yao, W., Weng, Y., Catchmark, J.M.

Improved cellulose X-ray diffraction analysis using Fourier series modeling

(2020) *Cellulose*, 27 (10), pp. 5563-5579. Cited 28 times.
www.springer.com/journal/10570
doi: 10.1007/s10570-020-03177-8

View at Publisher

66 de Souza, A.G., Junqueira, M.T., de Lima, G.F., Rangari, V.K., Rosa, D.S.

A New Proposal of Preparation of Different Polymorphs of Nanocellulose from Eucalyptus citriodora

(2020) *Journal of Polymers and the Environment*, 28 (4), pp. 1150-1159. Cited 7 times.
http://www.kluweronline.com/issn/1566-2543/
doi: 10.1007/s10924-020-01672-4

View at Publisher

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